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Stress and Information Search in Complex Decision Making:
Effects of Load and Time Urgency

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Abstract

The effects of information load (low, medium and high) and time urgency (absent/control, moderate and high) on three measures of information search/information utilization were investigated in a complex simulated decision making situation. Measures obtained were: 1) number of information search decisions generated by four-man teams participating in the simulation, 2) number of integrations based on their previous information search decisions (a measure which previous research has shown to predict successful high level organizational performance), and 3) number of respondent actions associated with information search (a measure which previous research has shown to relate to lower levels of successful organizational performance). Previously reported data showing that intermediate load levels result in optimal integrative performance were corroborated. Increases in time urgency resulted in decreases in search activity in general, and in integrative utilization of information obtained through search in particular. High levels of time urgency in association with high load levels resulted in fewer search decisions and complete absence of integrative utilization, but produced an increase in respondent actions. The data suggest that an

optimal environment for high level decision makers with planning responsibility should contain optimal intermediate load levels, but should be kept relatively free of time urgency.

Stress and Information Search in Complex Decision Making:

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Organizational decision making, whether in industrial or in military settings, often occurs under less than ideal conditions. It is not unusual for a corporate vice president to be asked to produce a plan for the next five years "by tomorrow noon." In military settings, particularly under combat conditions, the need for rapid planning and decision making in response to enemy action is self-evident. The decisions made by corporate level executives and by senior military personnel can have major implications for future events and future outcomes. Consequently, it is important that decisions which might be affected by work load and time pressure should be optimized wherever and whenever possible. Ideally, decisions involving organizational planning should be based on the consideration of all available relevant informational dimensions and their interactive effects on each other and on the organization of its environment. As described and demonstrated in research efforts based on complexity theory (c.f. Streufert, 1978; Streufert and Streufert, 1978), complex decision making by senior executives who are interacting with a fluid and multi-faceted environment

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can be improved considerably and typically results in more successful outcomes if the executives: (1) engage in differentiation and integration of informational dimensions and (2) utilize these dimensions in their subsequent decisions.

Unfortunately, decision makers are not always in possession of all relevant information that would be useful (or necessary) for a forthcoming complex decision. They may not even be aware of some informational dimensions that might optimally be considered. Further, obtaining additional information and differentiating/integrating that information requires time and may at times delay the decision point beyond acceptable limits. Often a decision maker must consider the trade-off between engaging in more information search to obtain greater certainty or to include potentially more relevant information in complex decision making vs. the necessity to make decisions or conclude plans "on time." For example, decisions often must be made in advance of an externally imposed deadline or before a competitor may gain an advantage. In addition, information search activities add to the workload of the decision maker and potentially reduce the amount of time available for planning and decision making per se. To summarize: A decision maker who is faced with time constraints applicable to a complex situation must make some trade-off choices in considering whether further search activities are justified or whether a decision (or series of decisions) is to be made in the partial absence of potentially important and relevant additional information.

Research efforts on information search and information utilization have spanned several decades, yet many facets of search activity have hardly been explored by researchers. Most efforts have been concerned with information search in relatively simple soluable or insoluable problem solving tasks which have quite limited implications for the complex problems faced by high level organizational decision makers (e.g., the work of Lanzetta and associates with identification of tachistoscopically presented stimuli as in Driscoll and Lanzetta, 1965; Driscoll, Lanzetta and McMichael, 1967; Hawkins and Lanzetta, 1965; Sieber and Lanzetta, 1964). Research relating search to risk taking (e.g., Edwards, 1965; Edwards and Slovic, 1965) and efforts considering the statistical parameters of information (Becker, 1958; Howell, 1966), pay-off functions (e.g., Pitz and Reinhold, 1968; Rapoport and Tversky, 1966) or optimal modeling (e.g., Pitz, 1969; Pitz, Reinhold and Geller, 1969) also typically do not consider the complex problems and environments with which high level decision makers are frequently faced. Somewhat more appropriate is the theoretical approach of Festinger (1964) and Rhine (1967) explaining search via the "usefulness" concept (although research support for this view has only been partial, c.f. Canon, 1964; Rhine, 1967) and the approach of Feather (1966) who relates information search to the degree to which information obtained may lead to goal attainment or to punishment.

The work of Levine and associates (Levine, 1973; Levine and Samet, 1973; Levine, Samet and Brahlek, 1974, 1975) deserves special attention. Here subjects made decisions on the basis of sequentially presented

information, attempting to discover the single correct solution to a complex problem. For example, Levine et al. (1974) demonstrated that subjects who were free to decide when additional information was needed did obtain more information updates than subjects who did not control information acquisition on their own (even though both groups were free to decide when they wished to stop receiving information and progress to the decision making phase of their task). Decision making in the tasks employed by Levine and associates probably represents some intermediate level of organizational decision making (with some affinity to problem solving, since a single correct solution was to be obtained).

Research on information search activities in more complex settings (which are more or less equivalent to higher corporate or senior military tasks) has been reported by Karlins (1967), Karlins and Lamm (1967), Long and Ziller (1965), Stager (1967), Streufert and Castore (1971), and Streufert, Suedfeld and Driver (1965). Karlins (1967) and Karlins and Lamm (1967) found that persons with a more differentiative and integrative style of information processing (c.f. complexity theory) searched for more information when exposed to a complex environment than did persons who typically engaged in less differentiation and integration activity. Similar data were reported by Stager (1967). Streufert, Suedfeld and Driver (1965) and Streufert and Castore (1971) measured the effects of information load and of failure levels on information search and on information utilization. In their complex experimental simulation, teams of four subjects directed

the fate of a small developing nation which was threatened by economic problems and a military take-over attempt by a simulated opponent. Streufert et al. (1965) found that search activity decreases with increases in information load, yet decision makers who typically engage in more differentiation and integration activity were less affected by load increases than their counterparts. Streufert and Castore (1971) found that some failure increases self-initiated search activity while excessive failure levels diminish search. Again, persons with greater tendency to differentiate and integrate were less affected.

It appears quite important to distinguish between active search (self-initiated queries for information or actions leading to an increase in specific items of information) and passive search (permitting oneself to be exposed to ongoing information flow at certain levels). Streufert et al. (1965) have shown that self initiated search and delegated search activities do not covary. In some cases, the data for the two efforts appear even contradictory. Sanders and TerLinden (1967) found that more information is acquired before a decision is made when the rate of information presentation increases. Exposure to information appears to increase, particularly if the opportunity to revise a previous decision exists. For example, Gibson and Nicol (1964) and Pruitt (1961) have shown that the amount of information needed to modify a previous decision tends to be greater than the amount needed for the original decision. The possibility of revising one's decision, of course, reflects a general absence of time pressure; most decisions that were made under time urgency cannot be revised at a later date.

experimental simulation methodology, the interested reader is referred to Fromkin and Streufert (1976) and Streufert and Suedfeld (1977). Each of the four-man decision-making teams was given the task of directing the economic, intelligence, military, and negotiation activities of a small developing nation called Shamba which was plagued by an internal revolution. Subjects initially read a manual on the historical and economic characteristics of the nation, its present military, economic, and negotiation (international) status and its current problems. Further, participants were informed about latitudes and limitations of their potential actions, about the resources available to them, and about the operation of the simulation technology as it would affect them. They were told that they would be able to make any number of any kind of decisions throughout the game as long as they would not overspend their resources. Their decisions were to be recorded on special forms and communicated to the experimenters. Participant teams would play the TNG against a program for a number of periods of indeterminate length until the Shamba conflict was resolved in some fashion.

After spending two hours reading the manual on Shamba and listening to a 30-minute tape providing more detailed familiarity with the simulation environment, the TNG was begun. The simulation was divided into ten 30-minute playing periods, separated from each other by short intermission periods. Intermissions were used, in part, to collect paper-and-pencil scale data.

The first 30-minute playing period of the TNG was used to familiarize the participants with the simulation setting. During this period, the participants received ten messages (an optimal amount of

information according to previous research by Streufert and associates; e.g., Streufert and Schroder, 1965). One of the messages was marked URGENT (see below). After completing their first playing period, the participants were given the opportunity to ask additional questions about the game and were provided with food and soft drinks. Although data collection proceeded during this first period as in all future playing periods, the first period was considered a warm-up and the data were not utilized for analysis.

The first playing period was followed by nine additional periods of play. During three of these periods, the participants received six, during three other periods ten, and during the remaining three periods fourteen information messages (information load levels 6, 10 and 14). Each message was simple, consisting of a subject-predicate-object statement. The purpose of this simplicity was to assure that a message would not carry obvious secondary implications. For example, one message stated, "The opponent has invested 20 Million in steel mill construction." Messages were essentially pre-programmed. Twenty-five percent of the messages were concerned with economic, twenty-five with neogtiation, twenty-five with military, and twenty-five percent with intelligence events. Order of messages and event areas were randomized. As in previous runs of the TNG, manipulation checks indicated that the participants considered the events to be due to their own previous or to their (simulated) opponents' decisions in more than 80% of the cases.

In addition to information load, urgency was manipulated. Participants were informed at the beginning of the TNG that messages

marked URGENT required immediate responding, and that a response latency of more than one minute would most likely lead to failure. The participants did indeed respond rapidly to urgent messages: 93% of such messages yielded a response within one minute and another 4% produced responses in the second minute after receipt of the message.

Either zero, two (moderate urgency) or six (high urgency) messages received by participants during any single playing period were marked URGENT. All load conditions were paired with all urgency conditions. Absence of urgency (urgency level zero at loads 6, 10 and 14) was viewed as a control condition for comparison with previous data obtained in experiments where load alone was manipulated. It should be noted that an urgency level of six urgent messages under low load conditions (load 6) produced a situation where all messages received during that period of play required immediate response. The specific playing periods, reflecting nine different urgency/load combinations following the first (warm-up) period of play, were presented to each of the 20 teams in different random order.

Data Collection

As in previous research by Streufert and associates, the decisions made by the groups of participants were used as the basis for data analysis. Since the participants were free to make any kind of decision within the range of their resources, and since a number of sources of potential information were provided in the manual, information search and utilization of information obtained through search was in no way restricted. Responses by information sources were provided within the

load levels allowed by the program (see preceding page). Information search by decision making teams never exceeded the response potential of the program, so that realistic responding to information search was guaranteed.

Three measures of information search and utilization were based on the decisions of the participants:

1. Number of information search decisions. The number of decisions (including communications to information sources, actions designed to determine whether opponent response would be forthcoming, and other intelligence activity) directly intended to obtain additional information were counted.
2. Number of integrations (complex strategic decisions) based on information search. Decision making activity utilizing differentiation and integration was obtained in the manner of previous research by Streufert and associates (e.g., Streufert, 1970; Streufert and Schroder, 1965; Streufert, Streufert and Gorson, 1981). A decision matrix was constructed with types of decisions listed vertically (listings varied depending on the kinds of decisions made by that team) and time indicated horizontally. In this matrix, each decision is represented by a point vertically beneath the point in time at which the decision was made and horizontally beside the type of decision represented. Repetitive decisions were connected with horizontal lines and simultaneous, but different, decisions with vertical lines. Decisions made to provide the basis for future, different decisions (for example,

the investment of funds to gain population support in an area where the later construction of an industrial facility was planned) were connected with forward-directed diagonal arrows to the pre-planned later decision. Utilizing a previous decision for present purposes, where the earlier decision was not made with the present decision in mind, was indicated by a backward diagonal arrow. Matrices constructed for each of the 20 decision-making teams were analyzed according to scoring procedures derived by Castore and Streufert (1967) to produce independent measures of group decision making based on information search. The number of integrations measure counted the diagonal arrows in the decision matrix initiated from information search decisions (in either forward or backward direction) within any one playing period (i.e., during the time one particular load/urgency pair manipulation was in effect). This measure reflects the general tendency of a decision making team to utilize information obtained through search efforts in a strategic fashion.

3. Number of respondent actions associated with information search.

This measure is concerned with rapid, unstrategic decision making. It counts the number of decisions made during any one playing period which: a) are made in response to incoming information obtained via previous information search activity, b) are not connected by any diagonal to another previous or future decision, and c) reflect decisions made rapidly after receipt of incoming information (i.e., within three minutes).

While the number of integrations produced by a team of participant decision makers reflects more long-range planning activity (a characteristic necessary for successful high level decision making in industrial and military organizations, c.f. Jaques, 1978; Streufert and Streufert, 1978), respondent actions reflect an attempt to resolve present difficulties with immediate actions that are not part of any long-term planning. While such respondent actions are quite useful in emergency situations, they tend, if utilized frequently, to reflect lower levels of organizational and military decision making (c.f. Jaques, 1978) and tend to be associated with inadequate performance in high level decision making tasks. In other words, respondent decisions most often reflect actions that tend to occur with greater frequency (and more appropriately) below managerial levels or at low managerial levels.

RESULTS AND DISCUSSION

The data were analyzed with a three-way entirely within Analysis of Variance. The factors were Load (three levels), Urgency (three levels), and Measures (three levels). All F ratios were significant. The main effect for Measures is not of interest since its significance reflects characteristics of the measurement technique; by necessity, the count for number of information search decisions must exceed the number of integrations and the number of respondent decisions based on information search since the latter two can at most add to the first.

The significant main effect for Load ($F = 14.88$, $2/38$ df, $p < .001$) shows that the greatest information search activity (i.e., the sum of all three measures of information search and utilization) occurred under intermediate load conditions ($\bar{X} = 1.34$) with slightly less activity ($\bar{X} = 1.04$, $p < .05$) when information load was low and considerably less search activity when information load was high ($\bar{X} = 0.78$, $p < .01$).

The main effect for Urgency ($F = 13.41$, $2/38$ df, $p < .001$) reflects a steady decrease of search activity as urgency increased (\bar{X} values = 1.233, 1.11 and 0.87 search actions).

The Measure by Load interaction ($F = 4.28$, $4/76$ df, $p < .005$) indicates that the three measures were differentially affected by load variation. While the number of search decisions decreased only when load levels became quite high ($p < .05$), respondent decisions showed a slight increase ($p < .05$) from low ($\bar{X} = .75$) and high ($\bar{X} = .75$) to intermediate ($\bar{X} = 1.02$) load levels. Integrations based on information search showed a striking increase ($p < .005$) from low ($\bar{X} = .71$) and high ($\bar{X} = .32$) to intermediate ($\bar{X} = 1.30$) load levels. The data reflected in this two-way interaction corroborate previous findings of Streufert, Suedfeld and Driver (1965).

The Measure by Urgency interaction ($F = 13.41$, $4/76$ df, $p < .001$) indicates that despite a minimal drop in the number of information search decisions with increasing urgency, there was some decrease ($p < .05$) in respondent activity ($\bar{X} = .97$, .81 and .73) and a considerable decrease in integrative utilization of information gained through

search ($p < .01$; $\bar{X} = 1.08, .83$ and $.42$). It should be noted that stress generated by urgency apparently does not affect integrative (high level) performance in a way similar to the effects obtained from load generated stress: An inverted U-shaped curve producing some optimal level of the urgency variable for integrative information utilization was not obtained. (In contrast, the inverted U-shaped curve has been repeatedly shown to relate load stress to high level decision making performance.)

The Load by Urgency interaction ($F = 5.57, 4/76$ df, $p < .001$) reflects a decrease in search activity with increasing urgency under low load ($p < .05$) and intermediate load ($p < .01$) conditions. This finding was, however, not replicated for high load conditions: search activity remained quite low for all urgency levels. Most likely, a ceiling effect was obtained. Total search activity had already dropped to a level of less than 1.0 because of the superoptimal load, so it is likely that any additional effect of urgency was eliminated.

The obtained three-way interaction produced an F ratio of 4.181 (8.152 df, $p < .001$). Figures 1, 2, and 3 reflect the data represented by this interaction. As can be seen from a view of these figures, the data obtained differ greatly for the three measures, are similar for the control (urgency0) and low urgency condition, but show a sharp discrepancy when decision makers were exposed to high urgency levels. Load variation produced quite divergent information search activities, particularly under the high urgency manipulation.

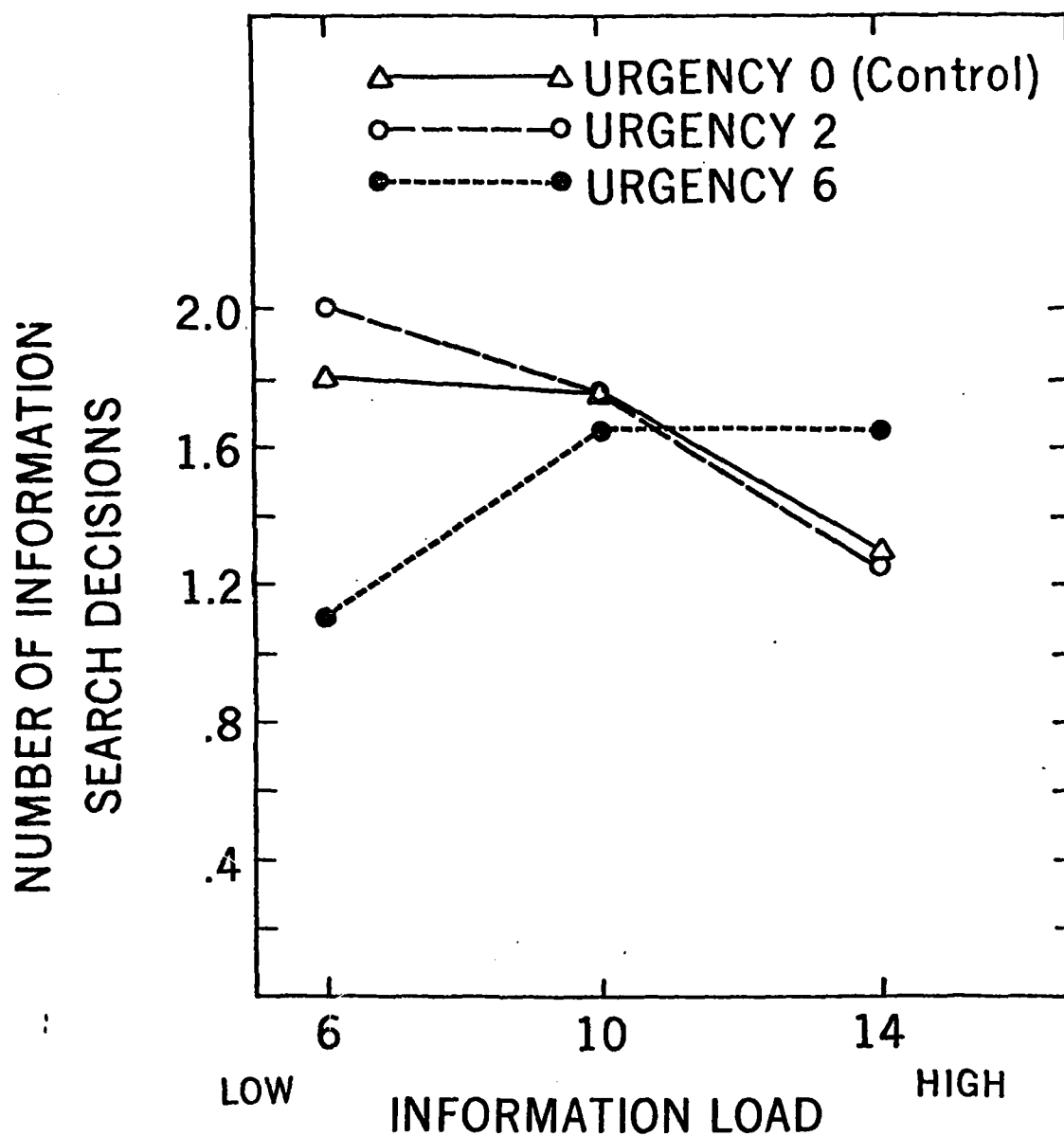


FIG. 1. EFFECTS OF INFORMATION LOAD AND TIME URGENCY ON NUMBER OF INFORMATION SEARCH DECISIONS

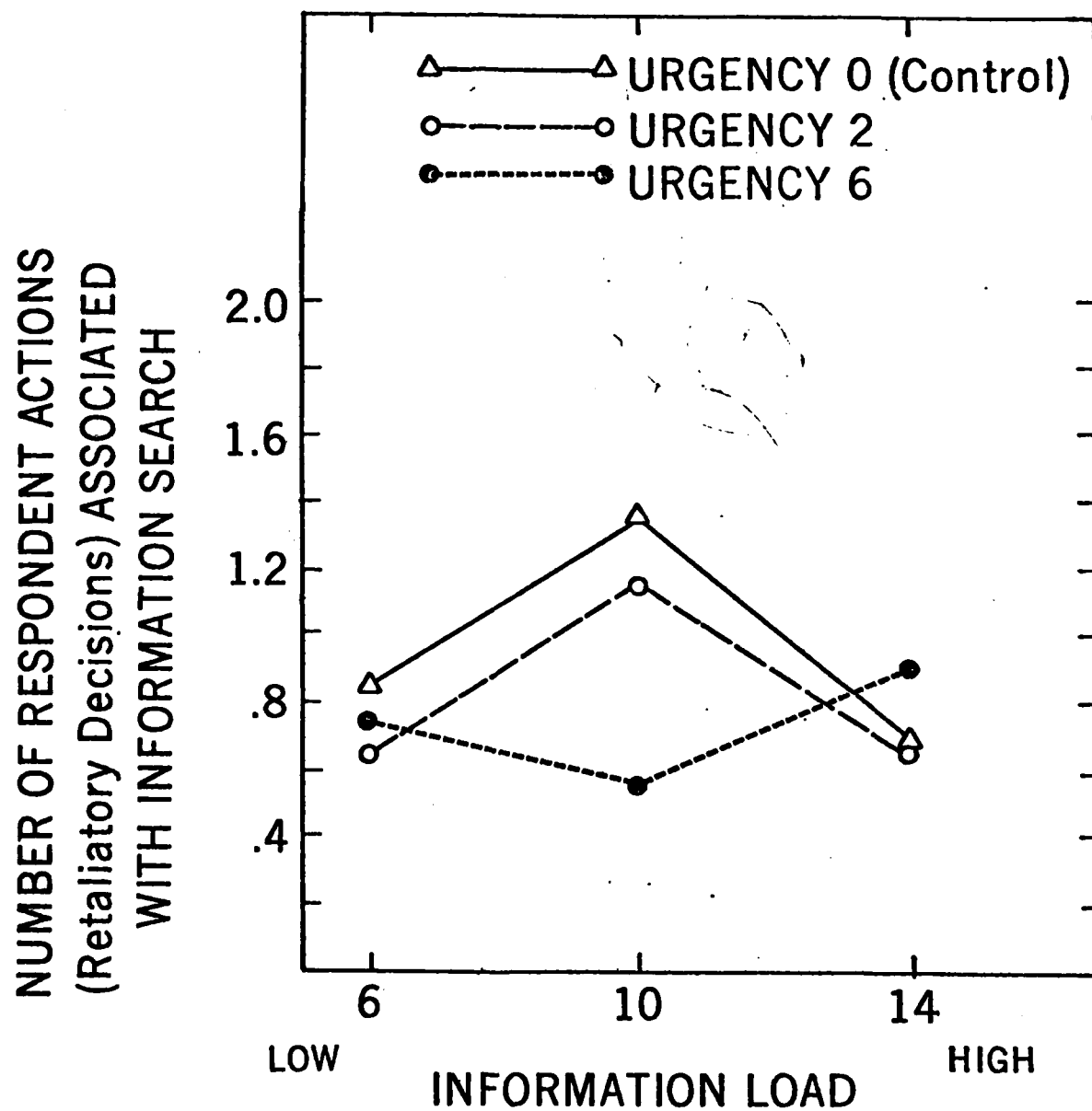


FIG. 2. EFFECTS OF INFORMATION LOAD AND TIME URGENCY ON THE NUMBER OF RESPONDENT DECISIONS BASED ON INFORMATION RECEIVED DUE TO PREVIOUS INFORMATION SEARCH

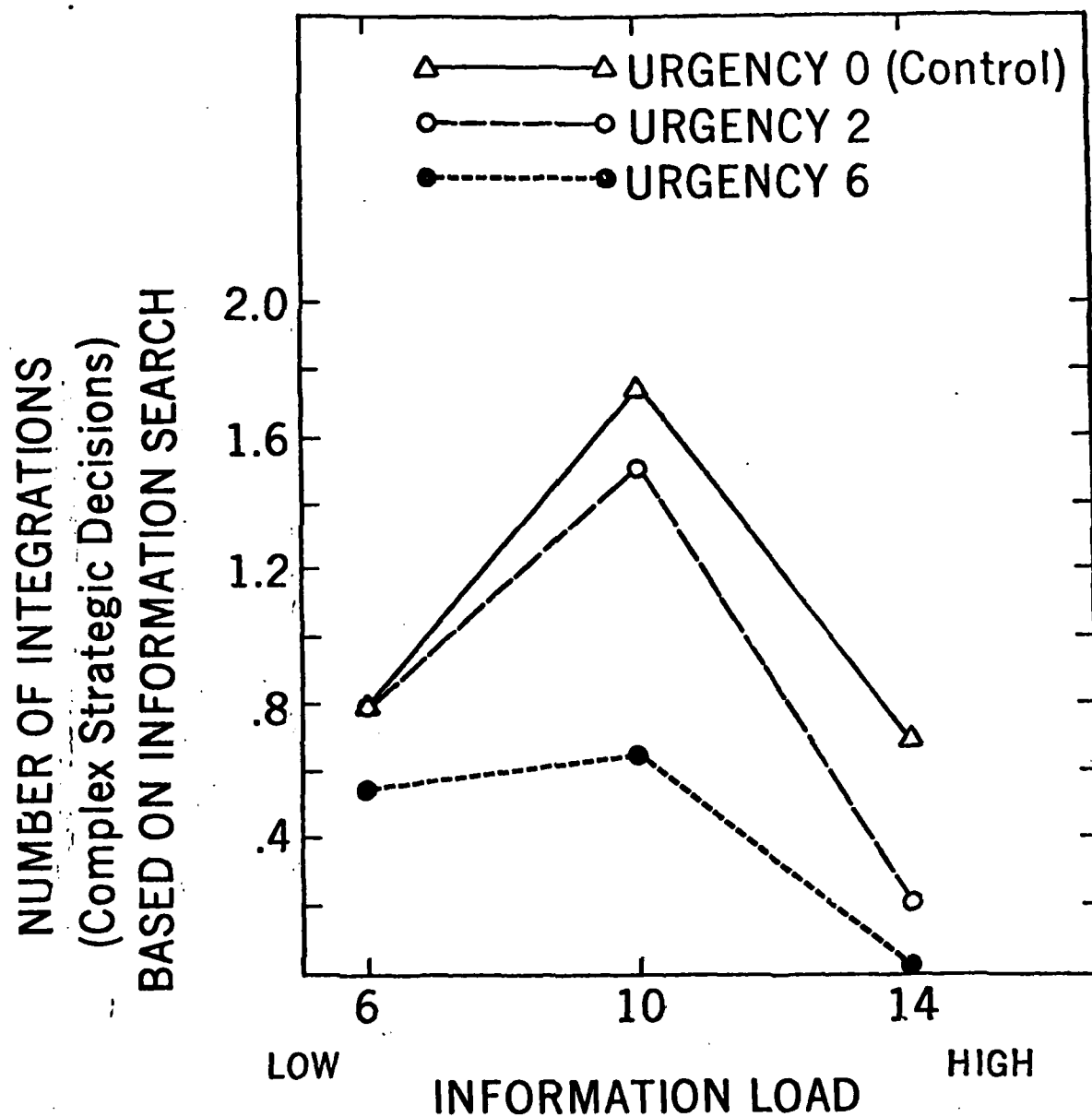


FIG. 3. EFFECTS OF INFORMATION LOAD AND TIME URGENCY ON NUMBER OF INTEGRATED DECISIONS BASED ON PREVIOUS INFORMATION SEARCH

As noted above, high levels of urgency do not produce the inverted U-shaped function relating stressor levels to differentiative and integrative managerial performance which was previously found with information load. In general, however, this function does hold in the absence of urgency and with relatively low levels of urgency. While search under these conditions generally decreased with increasing load (Figure 1), integrative utilization of information obtained via search efforts increased as optimum levels of load were reached (10 items of information per 30-minute period, c.f. the previous data of Streufert, 1970, and others) and then decreased as load became superoptimal. Respondent decision making based on information search reflected a similar pattern.³ However, these findings were drastically changed when decision makers were forced to cope with high urgency levels. Search paradoxically increased with increasing load, integrative utilization of information obtained through search remained low and dropped

³ The decrease in respondent decision making might not be expected if one follows the arguments of a simple dialectic approach which would propose that one form of decision making (here respondent utilization of information gained through search) should completely take over from another form (integrative responding) as that form of functioning becomes more difficult. However, as Streufert, Driver and Haun (1967) have shown, the organism exposed to overload at moderate levels tends to strain to maintain integrative processing, thereby reducing all forms of responding to incoming information until much higher overload levels are reached. At that point, respondent functioning would likely show a considerable rise. The increase in respondent decision making based on information obtained through search with high load levels for participants exposed to high urgency levels may well reflect that expected rise in respondent activity.

to zero as load reached high levels and respondent decision making increased as load reached superoptimal levels. Apparently the decision makers were straining to cope with the time demands of required rapid responding and clearly showed a loss of ability to plan decisions in an integrative fashion.

The data obtained in this research suggest that optimal utilization of information search is likely to exist only when time urgency is absent or kept to a minimum and when load levels are intermediate. Of course, this finding is applicable particularly to those (high level) settings where long-range planning and the integrative utilization of a number of facets of task and environment are important. For tasks at lower levels, where rapid and accurate responding is required (i.e., where an easily made choice between a correct and an incorrect response is needed), time urgency and high load may even be of some advantage. In a complex and fluid organizational setting where current decisions have long-range implications, however, that seems rarely to be the case. The argument by some executives that they consider themselves to be successful because of their ability to respond quickly and decisively may, in other words, be quite inappropriate.⁴ While that behavior may have been appropriate when the executive was in a more junior position, it has likely lost more and more of its meaning as

⁴ The argument that Type A behavior which is, in part, characterized by time urgency (c.f. Friedman and Rosenman, 1959) is the basis of success at high executive levels appears equally unjustified (Streufert, Streufert and Gorson, 1981).

she or he advanced to more senior levels. Nonetheless, the reinforcing quality of early successes at junior levels may keep the belief in the advantages of rapid and decisive responding alive - to the disadvantage of the executive and the organization.

If we are in the position to design environments for executives engaged in planning or other long-range decision making functions, or if we are able to regulate information flow to personnel at this level, then attempts at maintaining an optimal load level and avoiding urgency (plan far enough ahead to avoid last minute time pressures!) wherever possible, would be of considerable advantage. While complexity theory has not considered time urgency stress as a predictor variable, it has viewed other stressors (e.g., load and failure) as additive components of an inverted U-shaped function relating stressors to performance. Clearly, urgency (time) stress does not follow that pattern. An extension of the theory allowing for predictions made from stressors that do not sum with load may well be in order.

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